
TECHNICAL DATA

PLEXIGLAS

~I~

OPTICAL PROPERTIES



ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PENNA.

T E C H N I C A L D A T A

P L E X I G L A S



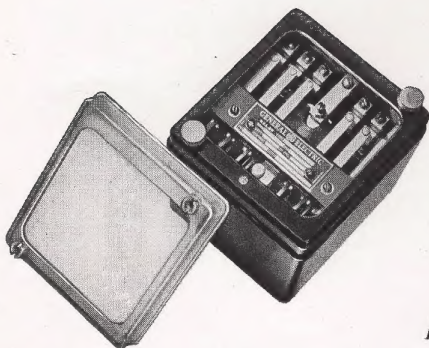
O P T I C A L P R O P E R T I E S

Fourth Edition



R O H M & H A A S C O M P A N Y

WASHINGTON SQUARE, PHILADELPHIA 5, PENNA.



MOLDED PLEXIGLAS

The data on the following pages are derived from measurements on PLEXIGLAS cast acrylic resin sheets but also apply, with reasonable accuracy, for parts properly molded of PLEXIGLAS acrylic resin molding powders. PLEXIGLAS molding powders are available in colors and in forms for compression and injection molding and extrusion.

THE colorless transparency of PLEXIGLAS, approaching so closely the theoretical maximum light transmission for a material of its refractive index, has made necessary several new techniques of optical measurement.

These techniques, devised in our laboratories where the acrylic resin plastics have been developed, are described on the following pages. The results of these and other tests on PLEXIGLAS are also given, to complete a useful table of optical data for engineers, designers, and architects.

This is the first in a series of technical booklets covering the optical, mechanical, thermal, chemical, and electrical properties of Plexiglas. Another series covers fabrication and installation of Plexiglas.

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PLEXIGLAS is the trade-mark, Reg. U. S. Pat. Off., for the acrylic resin thermoplastic sheets, rods and molding powders manufactured by the Rohm & Haas Company.

THE INDEX OF REFRACTION AND DISPERSION

VALUE The index of refraction of PLEXIGLAS to the sodium D lines, 5890 to 5896 Ångstrom units, is

$$N_D = 1.4885 \pm 0.0005$$

The dispersion, defined as the difference in the index for the 4861 Å and the 6563 Å lines of the hydrogen spectrum, is

$$N_F - N_C = 0.008$$

MEASUREMENT The movable half of the split prism of an Abbe refractometer is swung out of the way or removed. The refractometer is then placed so that the fixed half of the prism is in a horizontal or nearly horizontal plane. A moderately strong source of diffuse light, such as a 30 watt frosted bulb, is placed in the plane of the surface of the prism about twelve inches away. This source provides the necessary slightly divergent radiation which must go into the edge of the test sample.

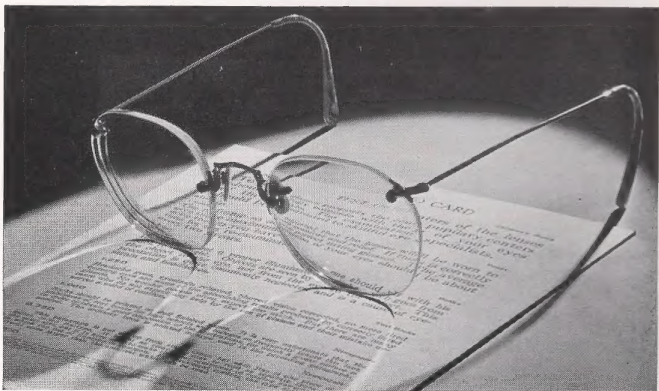
A rectangular test sample, just large enough to cover the surface of the glass part of the prism and at least 1/16 inch thick, is used. One of the surfaces and one of the ends should be well polished. The original surface of PLEXIGLAS is very satisfactory if any edge burrs caused by sawing out the sample are removed. The end of the sample may be polished to a satisfactory surface by rubbing it carefully on fine emery or Crocus cloth which has been wet with kerosene or motor oil. If a solu-

felt buffing wheel is available it may be used with rouge or a fine abrasive to speed up the polishing operation.

A fluid of approximately the same index of refraction as the solid must be used for wetting the sample to the prism face. Bromnaphthalene, usually used for this purpose, is unsatisfactory in this instance because of its solvent action on PLEXIGLAS. A saturated solution of zinc chloride made slightly acid with hydrochloric acid is therefore used instead.

A drop or two of the contacting fluid is placed on the prism face and the test sample placed on top of this fluid with the polished edge toward the light. Sufficient contacting fluid must be used to wet the sample down to the prism face. Intimate contact of test sample and prism face must be obtained.

The index of refraction and dispersion may now be determined in exactly the same manner that is ordinarily used for liquids. Close control of temperature is not necessary except for very precise work.



Plexiglas Lenses, by Unbreakable Lens Company

APPLICATIONS

Since its refractive index is close to that of ordinary glass, which varies from 1.51 to 1.53, experimental lenses can be machined from PLEXIGLAS before designing molds for silicate glass. These lenses show high optical efficiency and, because of the low dispersion value, little chromatic aberration. Experimental spectacle lenses made of PLEXIGLAS have proven light and accurate as well as resistant to breakage.

The index of refraction also sets up the minimum radius of curvature around which crystal-clear PLEXIGLAS can conduct light. Calculations show that light will follow PLEXIGLAS curved to a radius as sharp as three times the thickness of the sheet or bent through an angle as sharp as 48° .

VISIBLE LIGHT TRANSMISSION

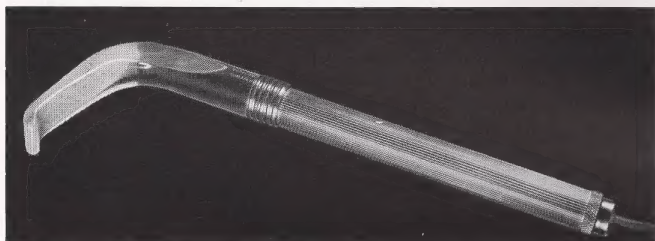
VALUE Percent transmission — 92
 Optical density — 0.036

In all ordinary thicknesses PLEXIGLAS will transmit all visible wave lengths (3600 Å to 7200 Å) of light as fully and faithfully as any other known solid of the same index of refraction.

MEASUREMENT The maximum possible light trans-
— DISCUSSION — mission for any material having
 two flat and parallel boundary
 surfaces is given, with sufficient accuracy for practical
 purposes, by the equation:

$$\text{Percent transmission} = \left(1 - \frac{(n - 1)^2}{n^2 + 1}\right) 100$$

when the material is in contact with air on each surface
 and where n is the index of refraction of the material.

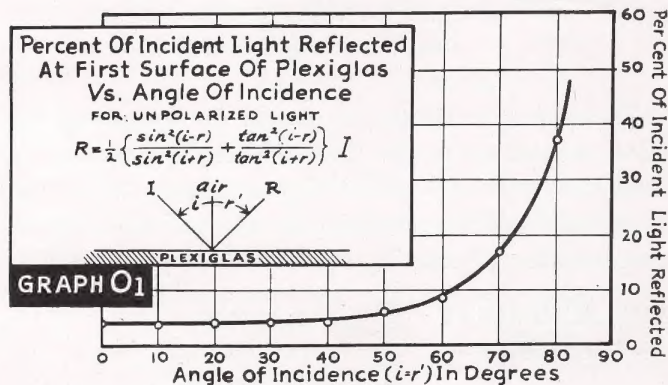


Curvite Medical Instrument

This relationship holds for materials which do not selectively absorb or reflect light within the wave length range to which the relationship is applied.

By substituting the value of 1.49, the index of refraction for PLEXIGLAS, in this expression the maximum light transmission theoretically possible is found to be 92.3% ; the remaining 7.7% is reflected, approximately 4% at each of the two surfaces. Since the transmission of PLEXIGLAS actually measures 92% in the visible range, we can conclude that it does not selectively reflect or absorb light. Of course the eye tells us this when we observe that it has no color.

If the light strikes the surface of the PLEXIGLAS at other than normal (perpendicular) incidence, the reflection at this surface will be greater than 4%. The amount



of light reflected by PLEXIGLAS at the surface of incidence is shown on graph O₁. The experimental data, as shown by the points, checks closely with the curve of

theoretical values. These data are of interest in connection with the engineering design of any application of PLEXIGLAS where light transmission is important.

For materials which do absorb selectively or for wave lengths of light at which absorption takes place within a material, the following relationship has been shown to hold with practical accuracy:

$$\text{Percent transmission} = (10^{-D}) 100 - R$$

where

D = the Optical Density = CMX

R = reflection losses which will vary from 8% to 4% depending on the amount of absorption of light within material with an index of refraction of 1.49

C = concentration of the coloring agent in the medium

M = constant for a given coloring agent at a given wave length of light

X = thickness of the medium

The above relationship is useful for computing the effect of thickness on the ultra-violet light absorption by clear PLEXIGLAS or the visible light absorption by colored PLEXIGLAS, and for computing the effect of changing the concentration of coloring agent in colored PLEXIGLAS.

MEASUREMENT

— METHODS —

The large number of different instruments commonly in use for measuring the light transmission of transparent materials fall into two general classifications:

- (1) those directly measuring the transmitted energy and,

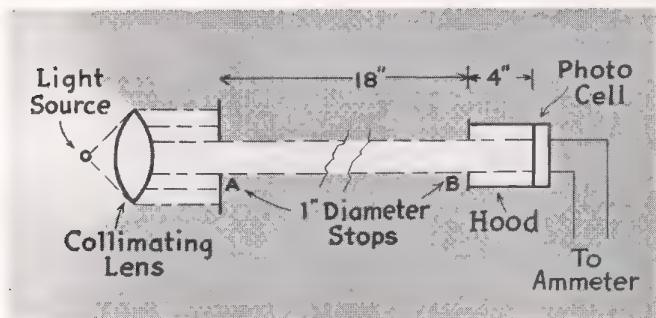


DIAGRAM OF HAZEOMETER

- (2) those comparing the transmission of the material with the transmission of a calibrated optical system.

One of the most popular industrial methods for measuring total transmission makes use of a barrier-layer photoelectric cell to measure directly the transmitted energy.

One form of this type of instrument is now specified for use with plastics by the U. S. Navy Aeronautical Division Specification P-41c. This type has also been accepted as a tentative test method by Committee D-20, on Plastics, of the A.S.T.M. It is sometimes called the Kline-Bowen Hazeometer and is constructed as shown in the diagram above. Other reasons for this particular choice of construction will appear later when the subject of light scattering is discussed.

The measurements are made by first adjusting the current in the lamp until the microammeter reads its full scale value of 100 microamperes. The sample of the

material whose transmission is to be determined is then inserted directly in front of stop B and the microammeter reading noted. This reading in microamperes is taken as the percent transmission of the sample.

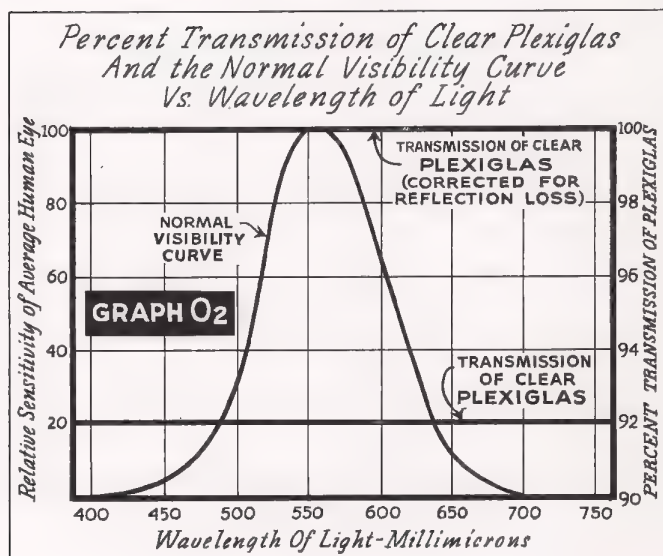
For highly transparent materials this method appears to be accurate to about $\pm 5\%$ of the transmission value under ordinary circumstances and at high transmission values. When care is taken to calibrate the photo-cell and the meter properly, this error can be reduced to $\pm 1\%$. In general, the errors of measurement by this method will be on the plus side, because of the redistribution of light from the repeated reflections between the sample at B and the surface of the photo-cell. For clear PLEXIGLAS this distribution of error shows up in the form of higher than theoretical (92.3%) transmission values.

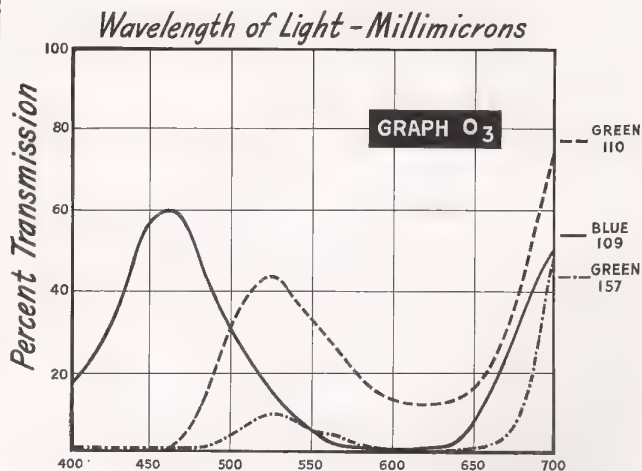
If a practical evaluation of the transmission is desired, care should be taken to choose the lamp size so that it may be operated near its normal voltage rating and to choose a photo-cell having a response curve similar to that of the eye.

Color transparency may be approximated by inserting a color filter in the path of the light in the apparatus just described. By using two or more color filters, some idea of the actual appearance of the sample may be expressed. By using three reasonably pure color filters to obtain a "tricolor" evaluation, the change in color resulting from various aging and weathering conditions may be shown.

When the transmission of a single wave length of light is desired, it is necessary to employ some form of spectrophotometer, a device for measuring or comparing the transmission of the material for a narrow spectral range. These data are actually in the nature of band-pass transmissions. Such data are useful in color control testing and may also be used in color specification, but it is not of much value in conveying information on the actual visual color appearance of a material.

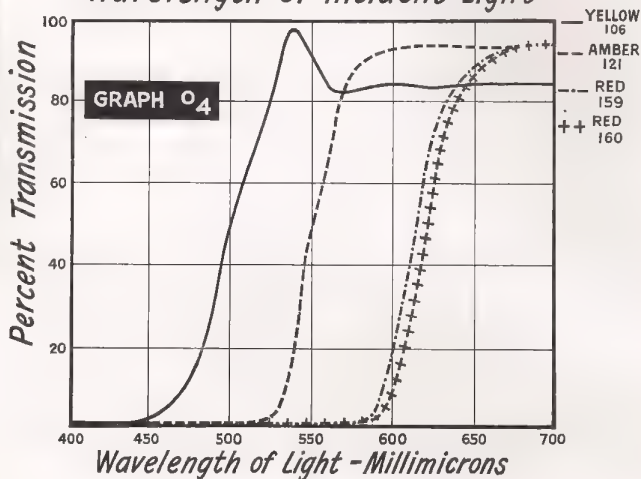
DATA The curves of graphs O₂, O₃ and O₄ were obtained on a Hardy Recording Photoelectric Spectrophotometer and are plotted with the wave length of light in millimicrons (1 millimicron = 10^{-9} meters) as the ordinates.





*Percent Transmission of
Standard Plexiglas Colors
Vs.*

Wavelength of Incident Light



The transmission data in graphs O₃ and O₄ are for standard PLEXIGLAS colors and apply to all thicknesses of the material.

The conversion from percent transmission to optical density is made by means of the relation.

$$\text{Optical density} = D = \log_{10} \frac{100}{\% \text{ transmission}}$$

On the following pages are shown data pertaining to the visible and ultra-violet light transmission of PLEXIGLAS.

APPLICATIONS

The crystal-clarity of PLEXIGLAS makes possible high optical efficiency in lenses, filters, etc., and is also used to advantage in decorative items which have a brilliant sparkle, especially on carved surfaces.

This transparency also gives a jewel-like depth to colored PLEXIGLAS, useful in jewelry. Its exceptional clarity also means that PLEXIGLAS can "pipe" light around curves and corners with no appreciable loss in intensity. Dental and medical instruments, which bring cold light to the fingertips of the operator, are probably the best-known applications of the principle. (See page 8.)

Edge-lighted signs which may now be curved to advantageous angles and displays in which the product is lighted through several feet of PLEXIGLAS are also possible.

ULTRA - VIOLET LIGHT TRANSMISSION

VALUE PLEXIGLAS transmits ultra-violet light continuously down to 250 millimicrons wave length. From a wave length of 350 millimicrons down to 250 millimicrons the optical density is proportional to the thickness of the PLEXIGLAS.

MEASUREMENT The transmission of ultra-violet light is best measured by spectrophotographic methods. Graph O₅ (page 18) shows some data thus obtained for two thicknesses of PLEXIGLAS. Plate I (page 17) shows two ultra-violet spectrophotographs. In the original print some lines down to 250 millimicrons are visible.

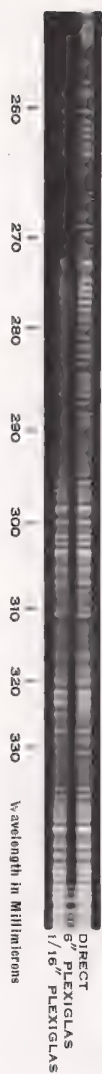
TABLE I

Approximate Full Sunshine Days Exposure at 40° North Latitude	Percent Blue Light Transmission*	Percent Ultra- Violet Light Transmission*
0	92	76
1	91	75
2	91	75
4	91	73
8	92	69
16	92	60
32	91	53
64	91	49
200	89	63**

* These measurements were made with a barrier-layer photoelectric cell. A Wratten No. 49 filter was used for the blue light transmission. A glass U. V. filter which passed a small amount of visible violet light was used in connection with a quartz mercury vapor source to make the U. V. transmission measurements. PLEXIGLAS .250" thick.

** The increase in U. V. transmission after 200 days' exposure is due to the development of a fluorescent property in the PLEXIGLAS.

ULTRA-VIOLET TRANSMISSION OF PLEXIGLAS COMPARED TO DIRECT RADIATION OF IRON ARC



COMPARISON OF THE ULTRA-VIOLET TRANSMISSION OF PLEXIGLAS WITH SOME INORGANIC TRANSPARENTS

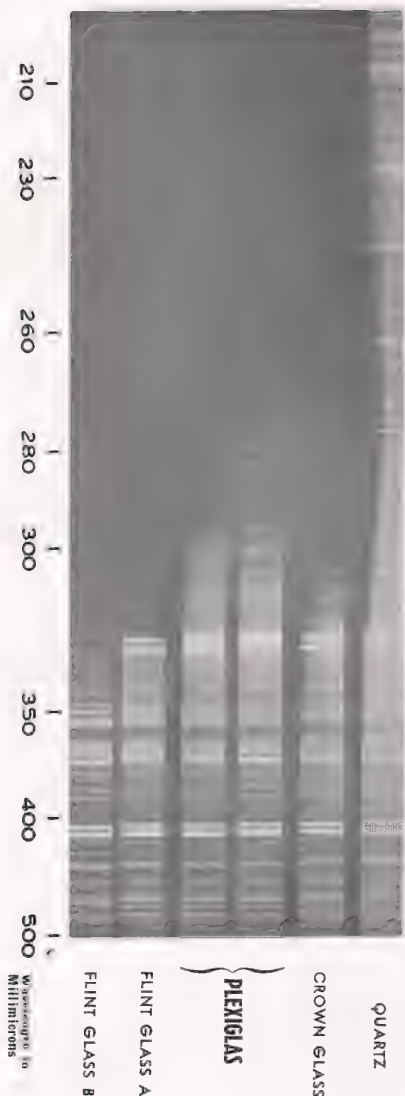
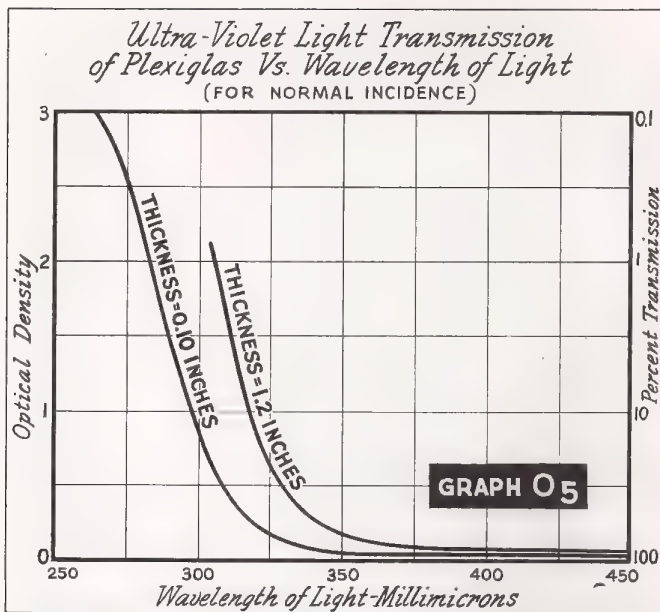


PLATE I



The ultra-violet transmission of PLEXIGLAS is a function of the thickness of the sample as is shown on graph O₅ and Plate I. It is also affected by the previous light exposure history of the material even though this previous exposure has not appreciably affected the white or blue light transmission. The approximate magnitude of this effect, commonly referred to as solarization, is shown in Table I for a 1/4" thick sample of PLEXIGLAS.

After two to three months' exposure, PLEXIGLAS develops a mild fluorescent property which causes an apparent increase in ultra-violet transmission as measured by the apparatus described in Table I. It is doubtful whether this increase is real, i. e., whether a plant growing under PLEXIGLAS would receive the benefit of this

additional radiation. It is more probable that the effective transmission remains close to the 50% transmission level reached after two months.

The relation $D = KX$, where D = optical density, K = a constant, and X = the thickness of the sample, approximates the effect of thickness on the light transmission of PLEXIGLAS in the range of 350 to 250 millimicrons.

This variation of ultra-violet light transmission with thickness of the medium is roughly illustrated by the data on new colorless PLEXIGLAS given in Table II.

TABLE II		
Thickness of PLEXIGLAS (inches)	Percent Transmission*	Optical Density (calculated)
0.065	95	0.02
.125	89	.05
.250	84	.08
.380	77	.11
* Measurement made with quartz mercury-arc source, glass U. V. filter and barrier-layer photo-cell.		

APPLICATIONS

The efficiency of PLEXIGLAS in transmitting beneficial ultra-violet radiation offers obvious advantages in hospitals and solariums. Although its efficiency does drop off to approximately 50% after two to three months, PLEXIGLAS is far better than ordinary glass and probably as good as or better than the types of silicate glass prepared especially for this purpose. Of course, PLEXIGLAS has an added advantage in its resistance to breakage.

PLEXIGLAS has also proved useful in scientific apparatus designed for use in the ultra-violet range of the spectrum.

X-RAY TRANSMISSION

VALUE Comparative tests show that PLEXIGLAS has about the same X-ray absorption as human flesh. More specifically, in thicknesses up to one inch at least, the X-ray transmission of PLEXIGLAS is proportional to its thickness and is approximately 13.6 times that of lead, for ordinary radiographic radiation.

MEASUREMENT A set of PLEXIGLAS blocks was prepared and arranged in stair-step fashion to interpose thicknesses of $\frac{1}{8}$ ", $\frac{3}{8}$ ", $\frac{7}{8}$ ", $1\frac{7}{8}$ ", and $3\frac{7}{8}$ " respec-

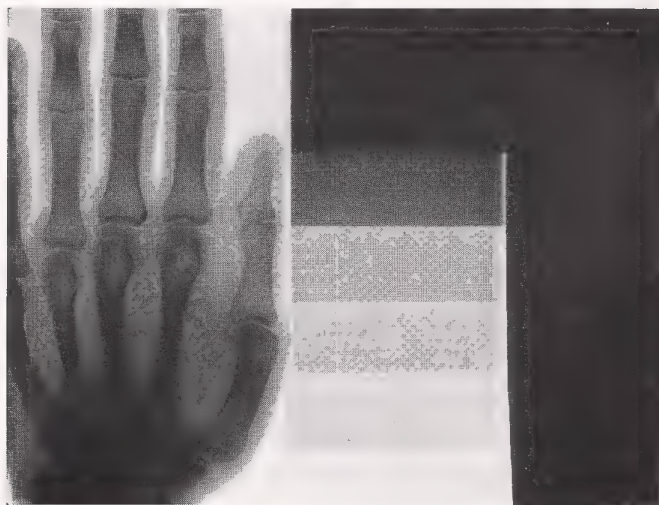


PLATE II

tively between the tube and the plate. In Plate II this stack of PLEXIGLAS blocks was placed in a central position, the right half being masked with a lead plate and a hand covering the left side.

A 3/16" lead shutter was constructed to give a 50% transmission. In another exposure this shutter disk was rotated over one end of the plate in place of the hand. Optical density measurements of the image of the steps of PLEXIGLAS, the 50% transmission area of rotating shutter disk, and of the lead plate yields the results in Table III.

TABLE III		
Absorbing Material	% Absorption	Optical Density
None	4.13	1.384
1/8" PLEXIGLAS	5.23	1.282
3/8" PLEXIGLAS	7.06	1.152
7/8" PLEXIGLAS	11.7	0.932
1 7/8" PLEXIGLAS	26.3	0.580
3 7/8" PLEXIGLAS	47.9	0.320
1/8" Lead	68.0	0.168
Rotating Shutter	8.66	1.063

The optical density of a photographic image is a linear function of the logarithm of the exposure for a considerable portion of the density range. Assuming a normal absorption law for PLEXIGLAS (neglecting scattering) it can be shown that the logarithm of the relative exposure, i. e., the logarithm of the transmission of the PLEXIGLAS, is a linear function of the thickness. Hence the optical density of the image will be a linear function of the thickness of the PLEXIGLAS interposed between the plate and the source of X-rays.

Upon plotting the above data (Optical Density vs. Thickness of PLEXIGLAS) it was found that the curve so obtained was linear up to a PLEXIGLAS thickness of about one inch. Its curvature from that thickness on is probably due to the non-linearity of the sensitivity curve of the plate, as mentioned above, although it might be also due to the failure of the assumed absorption law to hold for thicknesses of PLEXIGLAS above an inch. Interpolating linearly, we find that a thickness of 0.58 inch absorbs 50% of the incident X-rays.

The X-ray tube used for these exposures was a standard 20 milliampere Crooks tube with a tungsten target and the currents used were from 22 to 25 milliamperes.

APPLICATIONS

By using conventional or bone splints made of PLEXIGLAS, physicians can take Roentgenograms of the progress of knitting bone fractures without removing the dressing.

The material has also been used in special dishes for the X-ray examination of food and feces. PLEXIGLAS may also prove valuable as a top for X-ray tables or holders for X-ray film.

LIGHT SCATTERING TENDENCY

VALUE According to Navy Test Method P41c, PLEXIGLAS scatters only approximately 2% of the light falling perpendicularly to one surface. This value holds for PLEXIGLAS, with its original surface condition, in practically any thickness.

Practically all of this scattering of light is caused by minute surface irregularities which are generally too small to be seen except under a microscope. Practically none of the light scattering in PLEXIGLAS is due to internal haze or turbidity as the data in Table IV, obtained from an average run of production of PLEXIGLAS, will prove.

MEASUREMENT When a section of a transparent medium, having parallel surfaces, is illuminated per-

TABLE IV

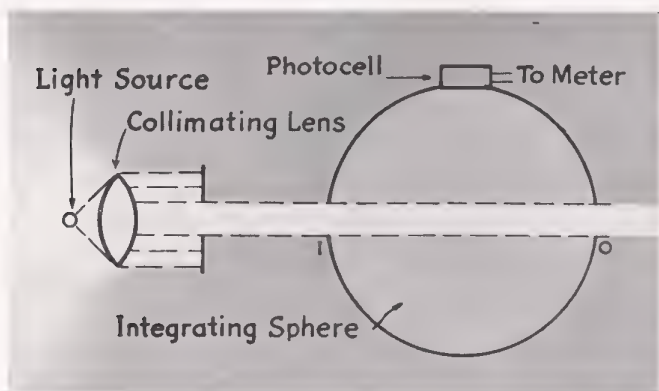
Thickness of Sample (inches)	Percent of Total White Light Transmission*	Percent Haze**
0.06	95	1.7
.15	95	1.9
.19	95	1.3
.25	95	1.8
.33	95	1.7
.38	95	2.5

* Measured by barrier-layer photo-cell at high illumination level.

** Measured by the second method described below.

pendicular to one surface with a collimated beam of light (all rays parallel) most of the transmitted light continues in an undeviated direction. The light which does not continue in the direction of illumination is said to be scattered by the medium. This tendency of a medium to scatter light may be due to surface imperfections or to internal non-uniformity.

One method for measuring the amount of scattered light makes use of an integrating photometric sphere. Three measurements are necessary, with the equipment assembled as shown in the following sketch:



MEASURING LIGHT SCATTERING TENDENCY

These are (1) the photocell current A , with the hole O stopped with a standard white block and the haze sample placed at I , (2) the photocell current B , with the hole at O unstopped and the haze sample placed at position I , (3) and the photocell current C with the hole at O unstopped and the haze sample removed from position I .

The light scattered may then be computed as a percent haze by the following relation,

$$\text{Percent light scattered or percent haze} = 100 \frac{B - C}{A}$$

A second method makes use of the equipment described on page 11. With the light intensity properly adjusted for a suitable current output from the cell, the current reading A is taken with the sample at position A, and the current reading B is taken with the sample at position B. The light scattering power is then computed as a percent haze from the equation,

$$\text{Percent light scattered or percent haze} = 100 \frac{B - A}{B}$$

Both of these methods are subject to a number of experimental and instrumental errors. With careful construction of equipment and careful manipulation, any given set-up may be made to reproduce readings to a practical degree of accuracy. Using suitable correction factors, the two methods can be made to agree satisfactorily.

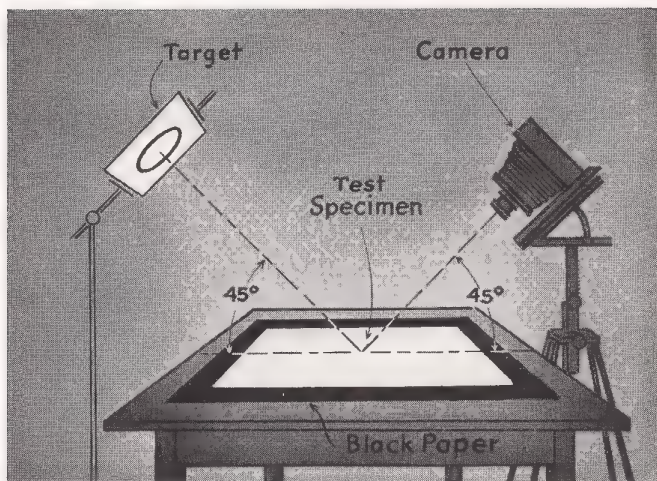
MINOR SURFACE IRREGULARITIES

AMOUNT The minor irregularities on the surface of PLEXIGLAS, defined as microscopic imperfections, are comparatively nil. The surface quality of PLEXIGLAS is practically of optical perfection.

MEASUREMENT There are no accepted methods of measuring or indicating the order of magnitude of the microscopic surface irregularities of transparent plastics,



PLATE III—A cross is scratched on surface to facilitate focusing of microscope.



MEASURING MINOR SURFACE IRREGULARITIES

and it is therefore not possible to assign an exact value to this property of the surface of PLEXIGLAS. It is obvious from the high light transmission and low light scattering tendency of PLEXIGLAS that its minor surface irregularities are of little consequence. This fact may be further checked by actual microscopic examination of its surface (see Plate III). Such an examination shows no ordered pattern of imperfections such as are ordinarily found on the surface of materials which have been given a good surface color but a poor optical surface.

The quality of a surface may be illustrated by comparing a target pattern with the reflection of this pattern from the surface under examination. Plate IV is just such a comparison made under the conditions illustrated in the above sketch.

The black paper is attached to the PLEXIGLAS with a bit of glycerine to eliminate a second reflection from the back surface.

The left half of Plate IV is a direct photograph of the target while the right half is a photograph of the reflection of the target from the surface of a piece of PLEXIGLAS. This photograph shows that there is no loss in detail due to this reflection, and may be taken to indicate that the reflection is entirely specular and therefore that there are no surface irregularities on the PLEXIGLAS which would tend to scatter the light or warp the pattern of this target.

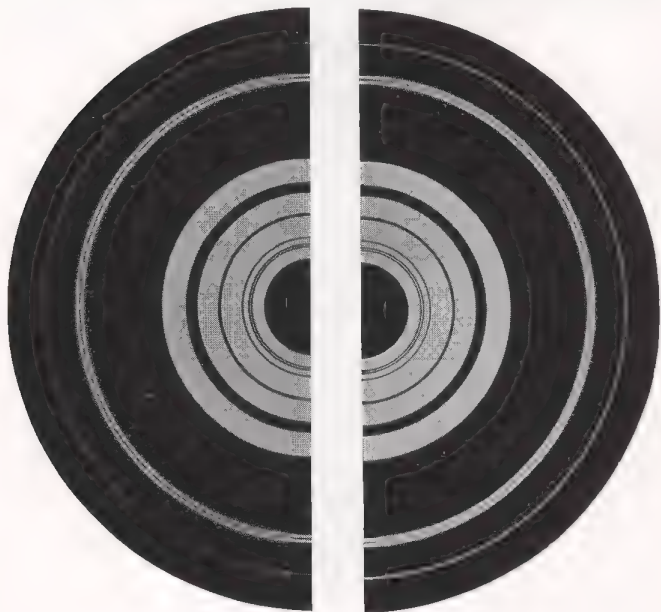


PLATE IV

MAJOR SURFACE IRREGULARITIES

AMOUNT *Thickness variation* — nominally -- $\pm 10\%$ within the sheet.

Prismatic effect — nominally not to exceed -- ± 6 minutes of arc. (1 minute of arc = .29 gunnery mils.)

Pattern distance or distortion value — nominally greater than 30 inches.

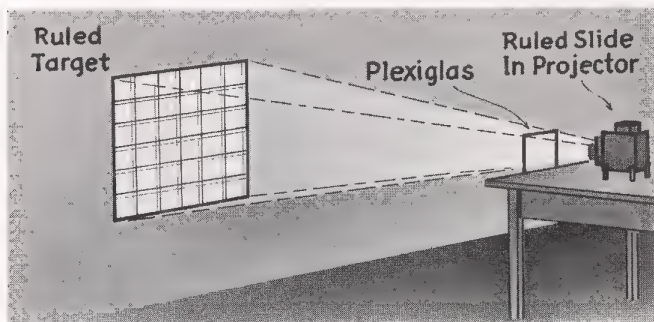
PLEXIGLAS with smaller major irregularities can be obtained on special order. Generally speaking, the smaller the area of the sheet the smaller will be the magnitude of the major irregularities.

MEASUREMENT Thickness variations as such do not greatly affect optical properties of a material except when these variations appear in waves or localized spots. When they do appear they may distort the shape or relative locations of images observed through the material or reflected from the material.

Actual caliper measurement of these thickness variations are difficult to make and to interpret in terms of optical effects, particularly when one is dealing with large sheets of the material.

Fortunately a convenient optical method is available for measuring the prismatic effect of these thickness variations. The equipment for this test method consists of a good lantern-slide projector, a slide ruled with a fine line cross and a screen ruled with a multiple cross

of fine parallel vertical lines and fine parallel horizontal lines one-quarter or one-half inch apart as shown on the sketch below. The projector is set up at a distance of 25 or 50 feet from the screen and adjusted to project an image of the special slide on top of the center cross of the screen. The transparent sheet is then passed directly in front of and about 12 inches from the objective lens of the projector, perpendicular to the axis of projection. While the sheet is being passed back and forth in front of the projector, the image is watched for displacement relative to the cross on the screen.



MEASURING MAJOR SURFACE IRREGULARITIES

The prismatic effect is calculated from the above observation by the relation

$$\text{Deviation} = 3437 \times \frac{\text{displacement of image in inches}}{\text{distance—projector to screen— in inches}}$$

= minutes of arc.

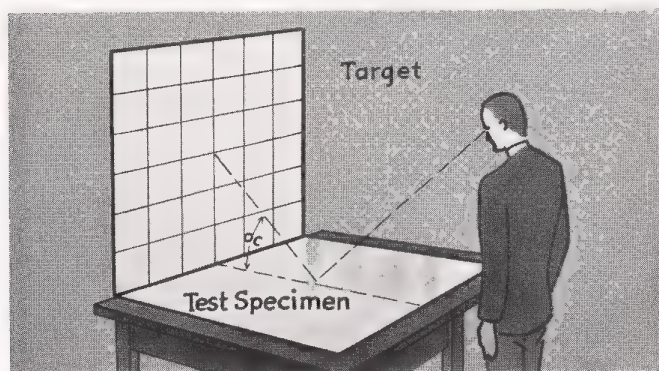
A second factor in connection with the surface irregularities and optical uniformity of the sheet may be measured with the same equipment. This is the pattern or distortion distance factor, determined by moving the

sheet of material toward the screen, while taking care to hold it parallel to the screen. If optical irregularities, either surface or body, are present in the sheet, a hazy or diffuse pattern of these irregularities will show on the screen. This pattern will again disappear as the sheet is moved still closer to the screen.

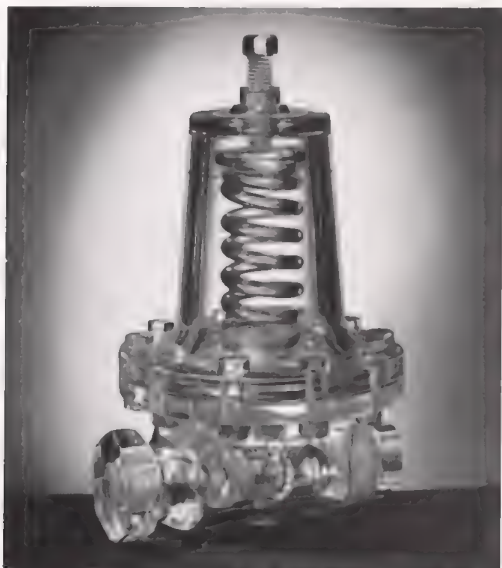
The pattern distance is defined as the distance from the sheet of material to screen, in inches, when the pattern is no longer perceptible. The greater this distance, the better are the optical qualities of the sheet since, for any given irregularities, the closer the sheet to the projector, the greater the effect on the image on the screen.

The value obtained for this latter test is somewhat affected by the optical constants of the projection system. The value stated for PLEXIGLAS was determined with a standard type lantern-slide projector having a $2\frac{1}{2}$ -inch diameter, 12-inch focal length objective.

The major surface irregularities of one surface of a sheet may be readily examined by reflection from a large target in the following manner:



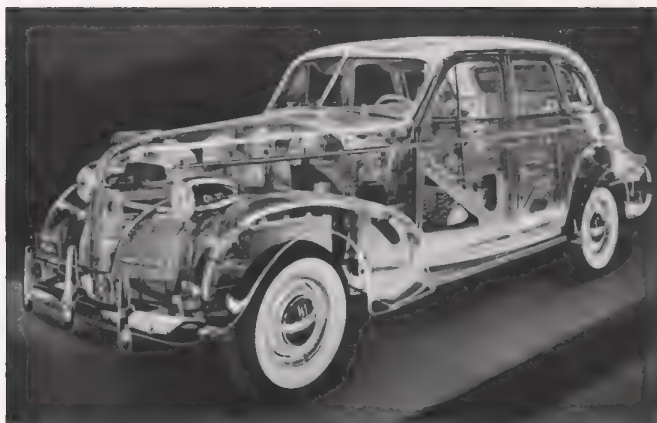
A rough quantitative comparison of samples can be made by determining the angle α for which the first line appears to deviate from the horizontal or to be excessively wavy. This is a very sensitive test for irregularities of one surface of the material but does not necessarily show the quality of the surface for use as a transparent medium in the path of direct observation.



A. W. Cash Valve Model by Suedlow

APPLICATIONS

Almost all applications of PLEXIGLAS depend on its freedom from surface irregularities which would distort the vision. Its wide use in aircraft windshields, inspection windows, transparent models, etc., all take advantage of this property.



Plexiglas Pontiac Body by Fisher



Lockheed 14 Nose and Loop Housing

OPTICAL HOMOGENEITY

PLEXIGLAS is an isotropic medium of unusual optical homogeneity. No lack of homogeneity can be detected in the flat sheet.

The presence of optical heterogeneity can be determined by examining the material by polarized light. Plate V is a photograph of 8 inch by 8 inch piece of $\frac{1}{4}$ -inch thick PLEXIGLAS which was photographed in



PLATE V

a special large-area photoelastic set-up. It is apparent that there is no pattern. This shows that there are no mechanical strains and no striae, cords, reams, or granular structure within the sheet.

In some of the shapes of large volume or cross section, such as rods, blocks or pieces which have been formed from sheet material, a polarization pattern can be observed. But even in these cases the heterogeneity is too little to be detected with the unaided eye.



Polariscope with Plexiglas Cover

APPLICATIONS

Since PLEXIGLAS is free of mechanical strains, it has lent itself to use with the various inspection instruments dependent on the use of polarized light. Displays which use polarized light and depend on strain patterns for their color and animation may also use PLEXIGLAS as a pattern-free base.

P E R M A N E N C E

Permanence is a purely comparative quality of any material. Its definition is very complex, and its measurement in absolute terms is extremely difficult.

PLEXIGLAS is only slightly affected by light, weather exposure, ordinary temperature changes, or combinations of these influences.

Since PLEXIGLAS is primarily a transparent medium, the permanency of its transparency is of first consideration. The following data on white light scattering tendency of two samples of 1/4"-thick PLEXIGLAS illustrate the remarkable permanence of its optical quality.

TABLE V			
Weathering or Aging Conditions	Change in Percent White Light Transmission	*Change in Percent Blue Light Transmission	Change in Percent Haze
200 full sunshine days (700 calendar days) at 40° N. lat..	—1	—2	nil
2000 hours in Atlas Fadometer	—8	—26	+3
Negative sign indicates decrease in transmission.			
* Blue light as passed by Wratten No. 49 filter.			

The most logical observation regarding the excellent resistance of PLEXIGLAS to all types of service conditions is based on actual service reports. In more than seven years of experience very little of this material, when

properly installed, has failed due to poor resistance to weathering or aging conditions. Under the severest condition of exposure to sunlight some solarization and yellowing will be noticed but this is usually negligible.

Under comparable conditions of exposure, PLEXIGLAS withstands weathering far better than any other type of plastic. Plate VI shows the result of a comparative test in which samples of six plastics were exposed simultaneously at approximately 40° north latitude.

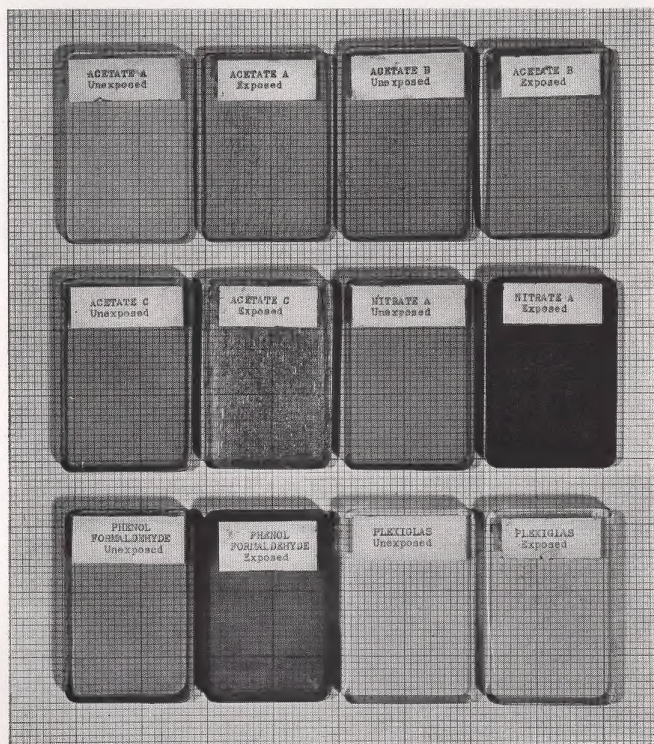


PLATE VI



Plexiglas Outdoor Sign, New York World's Fair

APPLICATIONS

The wide use of PLEXIGLAS in all types of aircraft is due in large measure to the permanence of its optical quality, as well as to its high impact resistance and light weight. After seven years of service in all kinds of weather PLEXIGLAS has proven so satisfactory that large transparent sections are playing an increasingly important part in aeronautical design.

Almost unique among thermoplastics in this respect, its excellent resistance to weathering makes PLEXIGLAS suitable for outdoor, three-dimensional signs.



Plexiglas Cockpit Canopy, Lockheed P-38



Signs, General Motors Building, New York World's Fair

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ROHM & HAAS CO.



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